CLAIMS

1. Method for determining the effects of mechanical stress on an object composed of a solid material, according to which method the strains and stresses generated by the mechanical stress at a plurality of points in the object are calculated by means of a numerical calculation method in inelastic mode, in which the behaviour of the solid material is represented by a polycrystalline microscopic behaviour model using a plurality of "grain" blocks whose strains is determined on the basis of a plurality of slip systems peculiar to the solid material, the trace of the tensor of the microscopic strains being zero, each "grain" block having an orientation and a volume fraction, characterized in that:

- the number of "grain" blocks is less than or equal to ten,
- the number of slip systems is less than or equal to six,

in addition, the microscopic model optionally uses:

- up to seven "grain boundary" blocks which each have an orientation and a volume fraction and whose deformation is determined on the basis of at least one opening system, the trace of the tensor of the microscopic plastic strains of each "grain boundary" block being positive,
- at most one "hole" block which has a variable volume fraction and whose plastic deformation is purely

in volume and whose microscopic plastic strains tensor trace is positive.

2. Method according to claim 1, characterized in that the six slip systems associated with a "grain" block and defined in an orthonormal coordinate system associated with the "grain" block by the normals to the slip planes and by the slip directions are such that the twin of the orientation matrix associated with each slip system is constituted only by 0, 1 or -1.

3. Method according to claim 1 or claim 2, characterized in that, for an isotropic material having a cubic structure, the deformation is determined on the basis of two families of three slip systems, a first family corresponding to the faces of the cube, and the second family corresponding to the planes at 45° to those faces, and in that the number of "grain" blocks is equal to seven, the "grain" blocks being obtained by symmetrization of two primitive "grain" blocks located on the 45° great circles of the pole figure.

4. Method according to any one of claims 1 to 3, characterized in that the evolution of the texture of the material is also determined by calculating the rotation $\underline{\underline{Q}}$ of the crystal lattice of each "grain" block relative to a corotational coordinate system.

5. Method according to claim 4, characterized in that, for an isotropic material having a cubic structure, the number of "grain" blocks is equal to ten.

6. Method according to any one of claims 1 to 3, characterized in that the progress of a phase transformation is also determined.

7. Method according to claim 6, characterized in that characteristics that are a function of the progress of the phase transformation are allocated to each "grain" block.

8. Method according to any one of claims 1 to 7, characterized in that the orientations and the volume fractions of the "grain" blocks are determined by adjustment on the basis of biaxial tension tests and tension-torsion tests.

9. Method according to any one of claims 1 to 8, characterized in that, in the absence of a "hole" block, the model for passing from the macroscopic level to the microscopic level for a "grain" block, which permits calculation of the tensor of the microscopic stresses $\underline{\underline{\sigma}}_g$ in the "grain" block as a function of the tensor of the macroscopic stresses $\underline{\underline{\Sigma}}$, of the tensor $\underline{\underline{\varepsilon}}_g^P$ of the microscopic plastic strains in the "grain" block and of the tensor $\underline{\underline{E}}^P$ of the macroscopic plastic strains, is written:

$$\underline{\underline{\sigma}}_g = \underline{\underline{\Sigma}} + 2\mu(1 - \beta)[\eta(\underline{\underline{1}} \otimes \underline{\underline{1}}) + \alpha\, \underline{\underline{1}}](\underline{\underline{E}}^P - \underline{\underline{\varepsilon}}_g^P)$$

with, $1/\alpha = 1 + \boldsymbol{D}\boldsymbol{E}_{eq}^{\max}$, and $1/\eta = 2 + 5\boldsymbol{E}_{eq}^{\max}$, $\boldsymbol{E}_{eq}^{\max}$ is the maximum value reached by the second von Mises invariant during deformation.

10. Method according to any one of claims 1 to 9, characterized in that the numerical calculation method is a finite element calculation method and in that a single "grain" block and optionally a "grain boundary" block or a "hole" block is (are) associated with each integration point of the finite element calculation method in such a manner that the distribution of the blocks is homogeneous.

11. Method according to any one of claims 1 to 10, characterized in that the numerical calculation method is a mechanical or thermo-mechanical calculation method involving time.

12. Method according to claim 11, characterized in that a "hole" block is used and in that the volume fraction of the "hole" block is not zero at the initial instant of the numerical calculation.

13. Method according to any one of claims 1 to 11, characterized in that the number of "grain boundary" blocks is greater than or equal to one, and in that a criterion is defined such that, when the criterion is met at one point in the object, a zero mechanical strength of the material is allocated to the point considered in order to simulate the presence of a crack.

14. Method according to any one of claims 1 to 8 and 10 to 12, characterized in that a "hole" block is used, and in that a criterion is defined such that, when the criterion is met at one point in the object, a zero

mechanical strength of the material is allocated to the point considered in order to simulate the presence of a crack.

15. Method according to any one of claims 1 to 14, characterized in that the object of solid material is a metal workpiece, and in that the mechanical stress is the mechanical stress associated with a shaping operation by plastic deformation, such as, in particular, pressing, drawing, rolling, bending or forging.

16. Method according to any one of claims 1 to 15, characterized in that the object of solid material is a metal workpiece, and in that the mechanical stress is a mechanical stress corresponding to the use of the metal workpiece.

17. Method according to claim 16, characterized in that the use in service of the workpiece generates at least one phenomenon from among the phenomena of creep, fatigue and fatigue-creep.